의학석사 학위논문

Focal anterior displacement of the thoracic spinal cord without evidence of spinal cord herniation or an intradural mass on MR imaging

척수 탈출증 또는 경막내 종양 없이 발생한 흉추부 척수 국소 전방전위의 자기공명영상학적 소견

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Focal anterior displacement of the thoracic spinal cord without evidence of spinal cord herniation or an intradural mass on MR imaging

by
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A thesis submitted to the Department of Clinical Medical Sciences, Graduate School in partial fulfillment of the requirements for the Degree of Master of Science in Clinical Medical Sciences at Seoul National University College of Medicine

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Professor Jin Sup Yeom Chairman
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ABSTRACT

Introduction: This study aimed to report MR findings on the focal anterior displacement of the thoracic spinal cord in asymptomatic patients without a spinal cord herniation or intradural mass.

Methods: Between 2007 and 2011, we collected a total of 12 patients (male: female = 6:6; mean age, 51.7; range: 15–83 years) with focal anterior displacement of the spinal cord and without evidence of an intradural mass or spinal cord herniation. Two radiologists retrospectively reviewed the MR imaging findings in consensus.

Results: In all patients, an asymmetric spinal cord deformity with a focal dented appearance was seen on the posterior surface of the spinal cord, and it involved a length of 1 or 2 vertebral segments in the upper thoracic spine (the first to 6th thoracic vertebrae). Moreover, a focal widening of the posterior subarachnoid space was also observed in all cases. None of the patients had myelopathy symptoms, and, with the exception of

one patient, they showed no focal T2-hyperintensity in the spinal cord. In addition, cerebrospinal fluid flow artifacts were seen in the posterior subarachnoid space of the affected spinal cord level. CT myelography revealed a preserved CSF flow in the two available patients.

Conclusions: Focal anterior spinal cord indentation can be found in the upper thoracic level of asymptomatic patients without a spinal cord herniation or intradural mass.

Keywords: Thoracic spine, MRI, Spinal cord deformity

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INTRODUCTION

Focal anterior displacement of the thoracic spinal cord in MR imaging is typically seen in patients with intradural arachnoid cysts or spinal cord herniation. Posterior intradural arachnoid cysts displace and compress the spinal cord by mass effect, whereas spinal cord herniation is a displacement of the spinal cord through a dural defect secondary to a traumatic, postoperative, or idiopathic etiology (1). Spinal cord herniation has been reported with increasing frequency in recent years, and it is an important differential diagnosis to consider with suspected intradural arachnoid cysts (2). Once a dural defect has occurred, cerebrospinal fluid (CSF) pulsation may push the cord through the defect, resulting in progressive myelopathy (3, 4).

We have collected rare cases of localized anterior displacement of the thoracic spinal cord without evidence of an intradural mass or spinal cord herniation in MRI. Most cases were found incidentally during lumbar spine MR examination, which routinely included whole spine T2 sagittal images as part of the scan protocol. To our knowledge, there has been no report to describe anterior displacement of the spinal cord without the

above-mentioned conditions. Herein, we report spinal MR findings in 12 patients who showed focal anterior displacement of the spinal cord without evidence of an intradural mass or spinal cord herniation.

MATERIALS AND METHODS

Since 2007, we have had a special interest in cases of focal anterior displacement of the spinal cord without evidence of an intradural mass or spinal cord herniation, and we have collected the cases. Whole spine T2-weighted sagittal images were included in all spine MRI study protocols at our institution. In the cases with focal anterior displacement of the spinal cord, additional T1- and T2-weighted sagittal and axial images were acquired at the same time. The inclusion criteria of this study were 1) localized anterior displacement of the spinal cord in the thoracic spine; 2) no evidence of an intradural mass, including cysts, adhesive bands, or spinal cord herniation; and 3) no previous history of trauma, surgery, or infection. One radiologist conducted a retrospective chart review, focusing on the clinical history, symptoms at presentation, and follow-up assessment.

MRI studies were performed on a 1.5-T scanner (Gyroscan Intera; Philips, Best, the Netherlands), according to the standard protocol at our institution with adjustment. T1- and T2-weighted images were obtained for both the sagittal and axial planes of the thoracic spine. The following scan

parameters were used: (a) sagittal T1-weighted spin-echo (repetition time /echo time, 400 msec /10 msec; section thickness, 4 mm; field of view, 556 × 349 mm), (b) sagittal T2-weighted spin-echo (3500/120; section thickness, 4 mm; field of view, 556 × 349 mm), (c) axial T1-weighted spin-echo (635/8; section thickness, 4 mm; field of view, 150 × 150 mm), and (d) axial T2-weighted spin-echo (3215/120, section thickness, 4 mm; field of view, 150 × 150 mm). Additional CT myelography was performed in two patients with the supine and prone positions when the physicians sought to exclude an intradural mass or dural defect in cases with diagnostic uncertainty.

In all cases, two radiologists analyzed the spinal MRI qualitatively in consensus, focusing on the level, pattern, segmental length of the spinal cord displacement, and cord signal change. The presence of a flow artifact was also evaluated at the affected spinal level. Four patients underwent a follow-up MRI study within 1–8 months of their first

examination; in these patients, the initial and subsequent images were also assessed, focusing on interval changes.

RESULTS

From 2007 to 2011, a total of 12 patients (male:female = 6:6) were included in this study. The mean age was 51.7 years (standard deviation ± 17.9 years, range 15–83 years). Table 1 summarized the initial MR findings for the 12 patients. In all patients, the focal anterior displacement of the spinal cord was associated with a widening of the dorsal subarachnoid space and was located in the upper thoracic spine level (T1–T6).

Intriguingly, an asymmetric dented appearance deformity along the posterior surface of the spinal cord was noted, which involved a length of 1 or 2 vertebral segments in all patients (Fig 1). In nine patients, the anterior spinal cord displacement was centered at the vertebral body level, while in the other three cases the anterior spinal cord displacement was at the intervertebral disc level without evidence of disc herniation. Axial T2-weighted images showed focal ventral displacement of the cord without focal spinal cord herniation and a relatively preserved anterior subarachnoid space. None of the patients showed cord signal changes at the level of cord displacement, with the exception of one patient with focal T2 signal

hyperintensity. In all patients, prominent CSF flow artifacts were also seen in the posterior subarachnoid space at the involved level. Additional CT myelography in two patients, however, showed a dilated posterior CSF space without any dorsal intradural filling defect or blockade. Furthermore, there were no findings of spinal cord herniation (Fig 2).

All patients were asymptomatic, and the anterior displacement of the spinal cord was an incidental finding in spine MRI. In four patients, follow-up MRI obtained at 1 and 8 months showed no interval change in the upper thoracic spinal cord deformity (Fig 3). None of the patients showed symptoms of myelopathy in the follow-up period.

Table 1. Focal anterior deviation of the spinal cord with a widening of the dorsal subarachnoid space

No.	Age	Sex	Symptom	MRI	Location	CSF flow artifact	Cord signal change	CT myelography	FU (months)
1	48	F	LBP	LS-spine	T4	+	-	-	4
2	48	M	LBP	LS-spine	T5	+	+	-	-
3	35	M	LBP	LS-spine	T2–T3	+	-	-	-
4	57	M	LBP	LS-spine	T4–T5	+	-	-	-
5	75	M	Hand tingling	C-spine	T4	+	-	-	-
6	59	M	Back pain	LS-spine	T1	+	-	-	8
7	55	F	LBP	LS-spine	T4	+	-	-	-
8	59	F	Back pain	T-spine	T5–T6	+	-	+	-
9	48	F	LBP	LS spine	T2	+	-	-	-
10	83	M	LBP	LS-spine	T4	+	-	-	1
11	38	F	Neck pain	C-spine	T2–T3	+	-	+	1
12	15	F	Back pain	T-spine	T4–T5	+	-	-	-

C = cervical, F = female; M = male; LBP = low back pain, LS = lumbosacral, FU = follow up

(A) (B)

Figure 1. Whole-spine sagittal T2-weighted images show incidental findings of focal anterior displacement of the thoracic spinal cord in two patients. (A, B)

Asymmetric dented appearance with ventral angulation of the cord and widening of the dorsal CSF space are present without an intradural mass or spinal cord herniation in the upper thoracic spine. Prominent CSF flow artifacts are present in the posterior subarachnoid space at the involved spine level. Arrow indicates spinal cord.

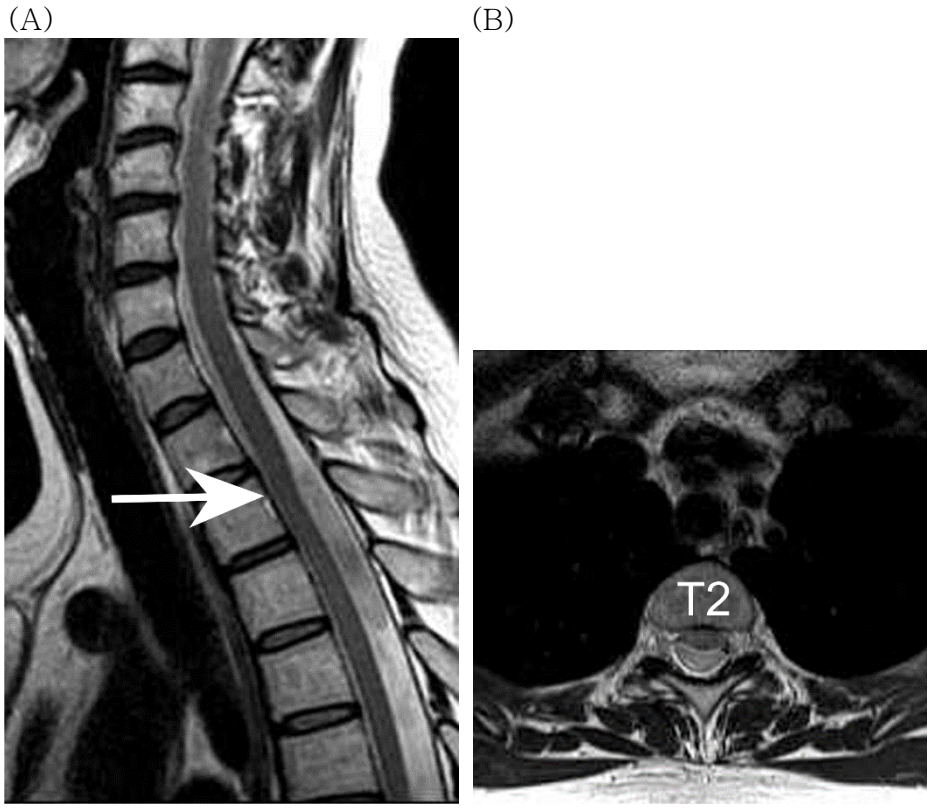
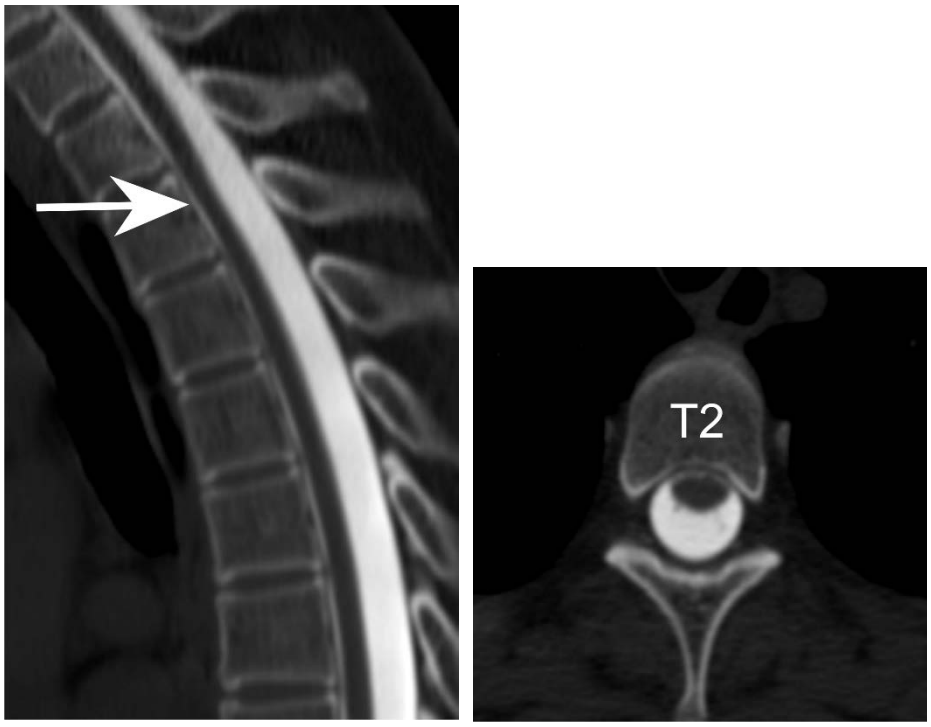


Fig. 2. Cervical spine MR (A–D) and additional CT myelography (E–F) of a 38–year–old woman who presented with neck pain.

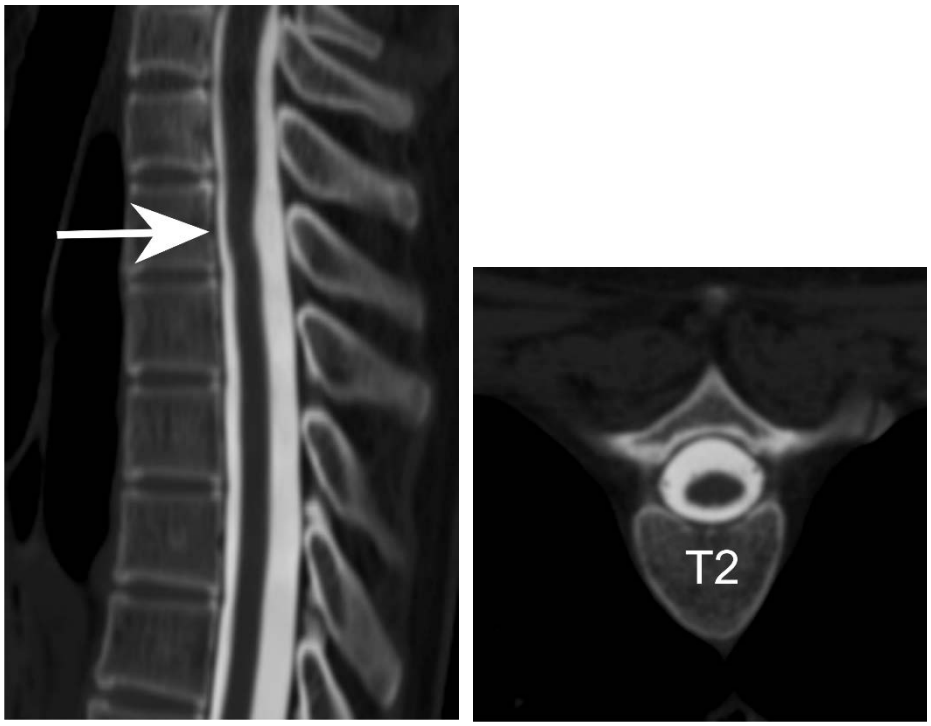
The sagittal T2–weighted image (A) and the axial T2–weighted image (B) show an anteriorly displaced spinal cord at the T2/3 level with a hypointense elongated flow artifact in the extended dorsal space at the same level.

(C) (D)



Sagittal (C) and axial (D) CT myelography in the supine position show a widening of the posterior space without an intradural filling defect or blockade (such as those caused by an arachnoid cyst).

(E) (F)



Sagittal (E) and axial (F) CT myelography in the prone position show preservation of the anterior subarachnoid space and intact CSF flow. There was no finding of spinal cord herniation or spinal cord adhesion. All axial images (B, D, F) were obtained at the T2 level. Arrow indicates spinal cord.

(A) (B) (C)

Fig. 3. Lumbosacral spine MR of a 48-year-old woman who presented with low back pain. A. the sagittal T2-weighted image shows an asymmetric dented appearance and anteriorly displaced spinal cord at the T4 level. B, C. Follow-up cervical-spine MRI study four months after the first examination. The sagittal T2-weighted image (B) shows no interval change in cord deformity. The axial T2-weighted image (C) shows ventral displacement of the cord without focal spinal cord herniation and a relatively preserved anterior subarachnoid space at the T4 level. The arrow indicates the spinal cord.

DISCUSSION

In this study, we reported asymptomatic patients with focal anterior displacement of the spinal cord at the upper thoracic level without an intradural mass or cord herniation. In all cases, an asymmetric dented appearance deformity along the posterior surface of the spinal cord was noted. To the best of our knowledge, such thoracic spinal cord indentation have not been previously reported.

We hypothesized that the focal anterior displacement of the thoracic spinal cord might result from a CSF pulsation pressure effect, as the asymmetric dented appearance deformity along the posterior surface of the spinal cord was situated in the upper thoracic level where the posterior subarachnoid CSF space is the widest. The thoracic spine has a normal kyphosis, and the spinal cord is normally situated in the ventral aspect of the spinal canal at the upper to mid thoracic spine, which could be a potential predisposition to such lesions. Another potential mechanism is that the negative pressure in the thoracic extradural space and the proximity of the heart may amplify the effects of CSF pulsation, resulting in these thoracic lesions. Furthermore, respiration and flexion and

extension movements of the spine might be involved in the etiology of the thoracic lesions.

Recently, Reardon et al. (5) described the presence of an arachnoid web in the dorsal subarachnoid space that caused a focal indentation of the upper thoracic spinal cord without an intradural mass or spinal cord herniation. They reported 14 patients who showed focal dorsal indentation in the upper thoracic spinal cord, and seven of the patients underwent surgery following their imaging studies. Five cases were surgically confirmed as arachnoid webs without evidence of an arachnoid cyst or ventral spinal cord herniation. T2 cord signal changes were demonstrated in ten patients, and seven of these patients showed syringomyelia at the level of cord indentation. However, there was no T2 signal change at the level of cord displacement in our study, with the exception of one patient with a focal change. In addition, the patients with focal T2 signal changes in our case showed no myelopathy symptoms, which indicated that the possibility of an arachnoid web was low in our cases.

Focal anterior displacements of the spinal cord with enlargement of the dorsal subarachnoid space in MRI are

considered characteristic findings of spinal cord herniation and intradural arachnoid cysts. Anterior spinal cord herniation is a rare disorder that does not have a clearly identified pathogenesis in most cases (6). Various mechanisms have been postulated to explain the initial dural defect and subsequent cord herniation (7). Most spinal cord herniations occur in the thoracic spine, predominantly at the third to 7th thoracic vertebra (T3–T7) levels (80% of all patients) (8, 9). Spinal cord herniation can be diagnosed using axial MRI or CT myelography by demonstrating anterior herniation of the spinal cord outside the margins of the dura. However, in our cases, no evidence of anterior herniation of the spinal cord was observed in axial MRI or axial CT myelography images.

According to Taylor et al. (10), the thoracic anterior spinal cord adhesion syndrome (TASCAS) represents two pathologies and includes anterior cord adhesion and anterior cord herniation within a single spectrum, with cord herniation considered at one end of the spectrum. In their study, four cases showed no spinal cord herniation but did show anterior spinal cord adhesion. TASCAS with cord adhesion is conceptually different from our cases, in that Taylor et al.

postulated spinal cord adhesion as a predisposing factor in spinal cord herniation and regarded these within one spectrum. In their study, most of the cases showed a cord abnormality adjacent to the intervertebral disc or upper margin of the disc with associated degenerative disc abnormality. In contrast, our cases showed different MR features: 1) most cases showed anterior cord displacement at the vertebral body level, not at the intervertebral disc level; and 2) no cases showed evidence of cord adhesion to the anterior dura, a visible CSF cleft in the anterior arachnoid space, or herniation of the spinal cord on prone CT myelography (Fig 2). All of our cases showed an asymmetric dented appearance deformity on the posterior surface of the spinal cord. We consider some cases of TASCAS to be within the spectrum of spinal cord herniation; however, some cases with features similar to TASCAS may be included within our suggested new entity.

Intradural arachnoid cysts are also considered in the differential diagnoses of our imaging findings. The most common location of an intradural arachnoid cyst is the dorsal subarachnoid space of the thoracic spine; symptomatic patients present with various symptoms, including motor weakness,

numbness, and pain (11-13). Intradural arachnoid cysts can be diagnosed based on their typical MR findings. Posterior intradural cysts compress and displace the spinal cord anteriorly by mass effect. As such, an intradural arachnoid cyst is expected to show wide, smooth symmetric spinal cord displacement rather than a dented appearance asymmetric deformity, as seen in our cases. The absence of the normal CSF pulsation artifact is an important clue in diagnosing intradural arachnoid cysts, as it implies CSF blockage by the cyst. On the contrary, a preserved normal CSF pulsation artifact was noted in our series. In previous reports, additional CT or MR myelography was used to confirm the diagnosis (to demonstrate the absence of intervening CSF and a posterior subarachnoid lesion), as well as phase-contrast MRI (to demonstrate normal pulsatile CSF flow dorsally, thus excluding a cyst) (4, 14). In our cases, additional CT myelography was performed in two cases, which revealed a dilated CSF space without a dorsal intradural filling defect or blockade, such as those caused by arachnoid cysts.

Despite the retrospective nature of the study and the rarity of this entity, we collected 12 consecutive patients. The

mechanism of the previously unreported thoracic spinal cord indentation still needs to be clarified. Because we hypothesized that the lesions could have resulted from the pressure effects of CSF flow pulsation, further study is warranted to describe the pathophysiology of this condition.

In conclusion, the anterior displacement of the thoracic spinal cord can be found in the MRI of asymptomatic patients without serious spinal lesions. The characteristic MR findings of an asymmetric dented appearance with anterior spinal cord displacement would be helpful for differential diagnoses of surgical diseases such as a spinal cord herniation or intradural mass.

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국문 초록

서론: 척수탈출증이나 경막내 종양이 없는 무증상 환자의 흉추부 척수에서 발견되는 국소전방전위의 자기공명학적 영상 소견을 보고하고자 한다.

방법: 2007 년부터 2011 년 사이, 척수탈출증이나 경막내 종양 없이 흉추부 척수에서 국소전방전위가 발견되는 12 명의 환자(남:여 = 6:6, 평균 연령: 51.7 세, 범위: 15-83 세)를 모았다. 2 명의 영상의학과 의사가 이 환자들의 자기공명영상을 후향적으로 분석하였다.

결과: 국소적으로 함입된 양상의 비대칭 척수 변형이 모든 환자의 척수 뒤쪽 측면에서 관찰되었다. 이러한 소견은 상부 흉추(상위 6 개의 척추 지역) 의 1 개 혹은 2 개의 척추 분절을 침범하였으며, 모든 환자에서 척수 뒤편의 지주막하 공간의 국소적인 확장이 관찰되었다. 어떤 환자도 척수병증의 증상을 호소하지 않았으며, 한 명을 제외한 모든 환자의 척수에서 국소적인 T2-조영증강은 관찰되지않았다. 또한, 뇌척수액 흐름에 의한 인공음영이 침범한 척수위치에 해당하는 뒤쪽 지주막하 공간에 관찰되었다. 추가적으로 컴퓨터 단층촬영 척수강조영술을 촬영한 2 명의 환자에서 뇌척수액 흐름은 이상소견이 없었다.

결론: 척수의 국소전방전위 소견은 척수탈출증이나 경막내 종양이 없는 무증상 환자에서도 상부 흉추부 위치에서 발견될 수 있다.

주요어 : 흉추, 자기공명영상, 척수

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